7 - System Module and User Interface

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List of abbreviations

ASIC	Application Specific Integrated Circuit
BB	Baseband
BLUETOOTH, BT	Bluetooth
BSI	Battery Size Indicator
CBus	Control Bus connecting UPP_WD2 with UEM
CCP	Compact Camera Port
CPU	Central Processing Unit
DBUS	Data Bus
DSP	Digital Signal Processor
EGSM	Extended – GSM
ESD	Electro Static Discharge
GPRS	General Packet Radio Service
GSM	Group Special Mobile/Global system mobile
HF	Hands free
HFCM	Handsfree Common
HS	Handset
I/O	Input/Output
IHF	Integrated hands free
IR	Infra red
IrDA	Infrared Association
LCD	Liquid Crystal Display
LO	Local Oscillator
MCU	Micro Controller Unit

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MIC, mic	Microphone
PA	Power Amplifier
DCS	GSM1800
PDA	Pocket Data Application
PWB	Printed Wiring Board
PLL	Phase Locked Loop
PWB	Printed Wired Board
RFBUS	Control Bus For RF RXReceiver
SDRAM	Synchronous Dynamic Random Access Memory
SIM	Subscriber Identity Module
TX	Transmitter
UEM	Universal Energy Management
UHF	Ultra High Frequency
UI	User Interface
VCO	Voltage controlled oscillator
VHF	Very High Frequency
VCXO	Voltage Controlled Crystal Oscillator
VGA	Video Graphics Array

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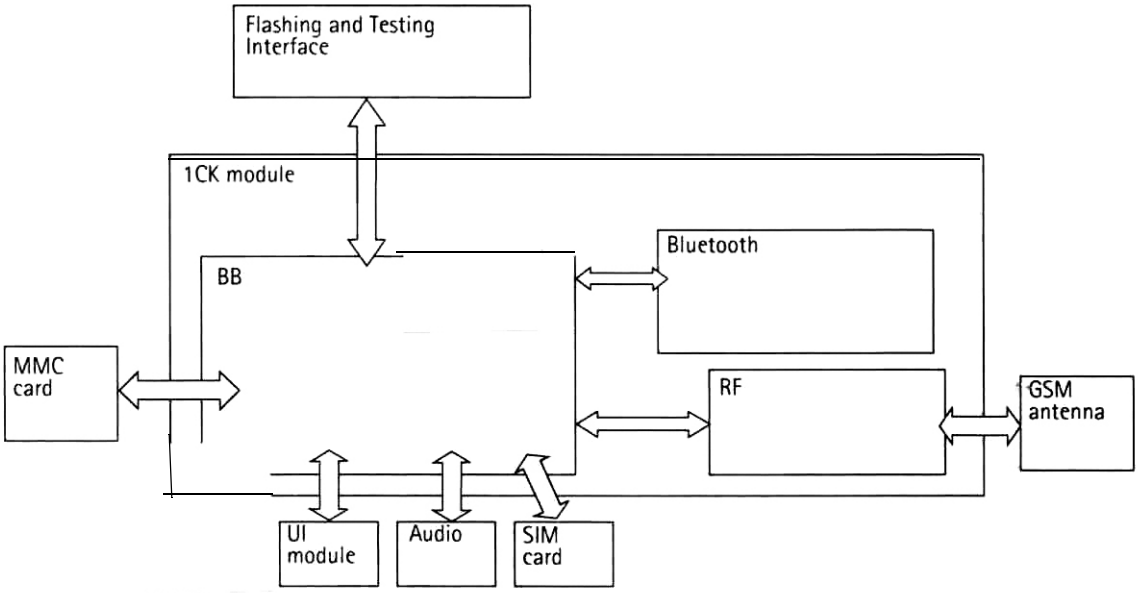
1BQ System Module Block Diagram

The 1BQ System module is the engine board of the RH-29 phone. It includes the base-band and RF functions of the phone and the Bluetooth module, fig. 1 below. External interfaces are drawn as arrows crossing 1BQ border.

Figure 1: 1BQ module block diagram



The Accessory interface is provided by Bluetooth. Only the Headset & Charger are galvanic interfaces.

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Baseband Technical Summary

The heart of the BB is UPP_WD2, which includes the MCU, DSP and Digital Control Logic. Power is supplied by the UEMK ASIC and a number of discrete regulators. Memory comprises of 2x 64Mbit (16Mbytes) Flash Memory Devices and 128 Mbit (16 Mbytes) SDRAM.

There are two audio transducers (Earpiece 8 mm and a MALT Speaker 16 mm) and External Galvanic Headset (DCT4) interface. MALT Speaker is also used to handle the ring tone. The MALT Speaker is driven by a discrete audio amplifier. In RH-29 there is only one microphone for both HS and IHF modes.

For Data connectivity there is the Bluetooth and an MMC card.

The Display is a GD82 type Colour Display with 66000 Colours and 176x208 pixels with backlighting.

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Functional Description

BB description

The BB Core is based on UPP_WD2 CPU, which is a PDA version of the DCT4 UPP ASIC. UPP_WD2 takes care of all the signal processing and operation controlling tasks of the phone as well as all PDA tasks.

For power management there is one main ASIC for controlling charging and supplying power UEM plus some discrete power supplies. The main reset for the system is generated by the UEM.

The interface to the RF and audio sections is also handled by the UEM. This ASIC provides A/D and D/A conversion of the in-phase and quadrature receive and transmit signal paths and also A/D and D/A conversions of received and transmitted audio signals. Data transmission between UEM and RF and the UPP_WD2 is implemented using different serial connections (CBUS, DBUS and RFBUS). Digital speech processing is handled by UPP_WD2 ASIC.

A real time clock function is integrated into UEM, which utilizes the same 32kHz-clock source as the sleep clock. A rechargeable battery provides backup power to run the RTC when the main battery is removed. Backup time is about 3 hours.

Memory configuration

RH-29 uses two kinds of memories, Flash and SDRAM. These Memories have their own dedicated bus interfaces to UPP_WD2.

Synchronous DRAM is used as working memory. Interface is 16 bit wide data and 14 bit Address. Memory clocking speed is 104 MHz. The SDRAM size 128Mbits (8Mx16).

SDRAM I/O is 1.8 V and core 2.78 V supplied by UEM regulator VIO. All memory contents are lost if the supply voltage is switched off.

Multiplexed Flash Memory Interface is used to store the MCU program code and User Data. The memory interface is a burst type FLASH with multiplexed address/data bus, running at 104/3MHz.

Both Flash I/O and core voltage are 1.8 V supplied by UEM's VIO.

Energy management

The master of EM control is UEM and with SW this has the main control of the system voltages and operating modes.

Modes of operation

RH-29 employs several hardware & SW controlled operation modes. Main Modes are described below.

- NO_SUPPLY mode means that the main battery is not present or its

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voltage is too low (below UEM master reset threshold) and back-up battery voltage is too low.

- In BACK_UP mode the main battery is not present or its voltage is too low but back-up battery has sufficient charge in it.
- In PWR_OFF mode the main battery is present and its voltage is over UEM master reset threshold. All regulators are disabled.
- RESET mode is a synonym for start-up sequence and contains in fact several modes. In this mode regulators and oscillators are enabled and after they have stabilized system reset is released and PWR_ON mode entered.
- In PWR_ON mode SW is running and controlling the system.
- SLEEP mode is entered from PWR_ON mode when the system's activity is low (SLEEPX controlled by SW).
- FLASHING mode is for production SW download.

Voltage limits

In the following the voltage limits of the system are listed. These are also controlling system states.:

Parameter	Description	Value
V_{MSTR+}	Master reset threshold (rising)	2.1 V (typ.)
V_{MSTR-}	Master reset threshold (falling)	1.9 V (typ.)
V_{COFF+}	Hardware cutoff (rising)	3.1 V (typ.)
V_{COFF-}	Hardware cutoff (falling)	2.8 V (typ.)
V_BU_{COFF+}	Back-up battery cutoff (rising)	2.1 V (typ.)
V_BU_{COFF-}	Back-up battery cutoff (falling)	2.0 V (typ.)
SW_{COFF}	SW cutoff limit (> regulator drop-out limit) MIN!	3.4 V SW changeable

The master reset threshold controls the internal reset of UEM. If battery voltage is above V_{MSTR}, UEM's charging control logic is alive. Also, RTC is active and supplied from the main battery. Above V_{MSTR} UEM allows the system to be powered on although this may not succeed due to voltage drops during start-up. SW can also consider battery voltage too low for operation and power down the system.

Clocking scheme

A 26 MHz VCXO is used as system clock generator in GSM. During the system start-up, UEM RC-oscillators generate timing for state machines. All clock signals of the engine

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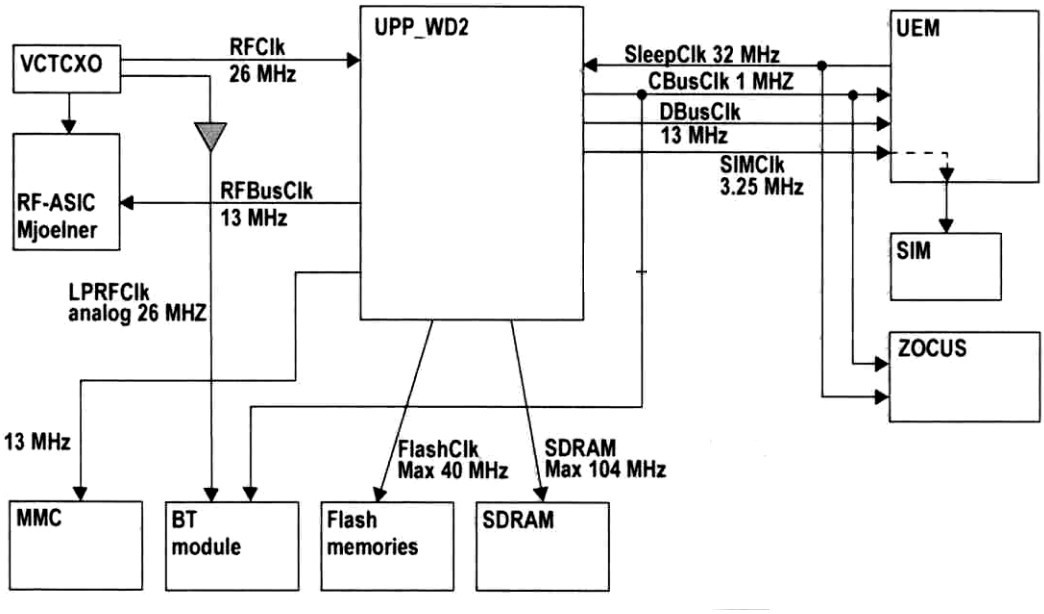
are illustrated in following figure.

Bluetooth uses 26 MHz clock.

Figure 2: RH-29 Clocking.



In SLEEP mode the VCXO is off. UEM generates low frequency clock signal (32.768 kHz) that is fed to UPP_WD2, Bluetooth and ZOCUS.

UPP_WD2 voltage/clock frequency adjusting

No external clock is available for UPP_WD2 before VCXO starts. As reset is released, the VCXO is running and MCU uses the 26 MHz clock while DSP is in reset. There are three identical DPLL's, for MCU, for DSP and for accessory interfaces, which can be controlled independently. The clock for MCU can be up to 104 MHz and 117 MHz is maximum clock Frequency for the DSP. These clock signals are used either directly (SDRAM IF) or divided down for the interfaces (e.g. flash IF).

Power distribution, control and reset

All power (except backup battery power) is drawn from the BL6-C Li-Ion battery located in the B cover. Current flows through ZOCUS current sense resister which is used for current measurement by ZOCUS and thus for remaining operating time estimation.

1BQ board contains one power ASIC, UEM and discrete regulators needed for generating the different operating voltages. The discrete regulators consist of an step-down DC-DC converter to power UPPWD2 voltage core and a step-up DC-DC converter for display module backlighting. The keyboard backlighting is powered with a discrete driver.

Power-up sequence (reset mode)

RESET mode can be entered in four ways: by inserting the battery or charger, by RTC alarm or by pressing the power key. The VCXO is Powered by UEM. After a 220 ms delay regulators are configured and UEM enters PWR_ON mode and system reset PURX is

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released.

During system start-up, in RESET state, the regulators are enabled, and each regulator charges the capacitor(s) at the output with the maximum current (short circuit current) it can deliver. This results in battery voltage dropping during start-up. When a battery with voltage level just above the hardware cutoff limit is inserted, the system may not start due to excessive voltage dipping. Dropping below 2.8 V for longer than 5 us forces the system to PWR_OFF state.

Powering off

Controlled powering off is done when the user requests it by pressing the power-key or when the battery voltage falls too low. Uncontrolled powering off happens when the battery is suddenly removed or if over-temperature condition is detected in regulator block while in RESET mode. Then all UEM's regulators are disabled immediately and discrete regulators are disabled as Vbat supply disappears.

Controlled powering off

For RH-29 powering off is initiated by pressing the power key and Power off sequence is activated in UEM and SW. Basically Power key cause UEM Interrupt to UPP_WD2 and SW sets Watchdog time value to zero and as this happens, PURX is forced low and all regulators are disabled.

If the battery voltage falls below the very last SW-cutoff level, SW will power off the system by letting the UEM's watchdog elapse.

If thermal shutdown limit in UEM regulator block is exceeded, the system is powered off. System reset PURX is forced low.

Uncontrolled powering off

This happens when the battery is suddenly removed. UEM's state machine notices battery removal after battery voltage has been below V_{COFF-} for 5 us and enters PWR_OFF mode. PURX is set low and all UEM's regulators are disabled.

Watchdogs

There are three watchdogs in UEM. The first one is for controlling system power-on and power-down sequences. The initial time for this watchdog after reset is 32 s and the watchdog can not be disabled. The time can be set using a register. This watchdog is used for powering the system off in a controlled manner. The other one is for security block and is used during IMEI code setting. The third one is a power key watchdog. It is used to power off the system in case SW is stuck and the user presses the power key. This WD is SW configurable.

There is also a"soft watchdog" in UPP_WD2. It is used to reset the chip in case software gets stuck for any reason. The Bluetooth module also contains a watchdog.

Charging

Charging control and charge switch is in UEM. There are two different charging modes;

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charging empty battery (start-up charge mode), and SW controlled charging.

UEM digital part takes care of charger detection (generates interrupt to UPP_WD2), pulse width modulated charging control (for internal charge switch) and over voltage and current detection. SW using registers controls all these.

Chargers

RH-29 BB supports a standard charger (two wires), Chargers ACP-8 and ACP-12, Cigarette Charger LCH-8 and LCH-12 are supported.

Battery

RH-29 Battery is a detachable, semi-fixed Lithium-Ion BL6-C battery. Nominal voltage is thus 3.7 V (max charging voltage 4.2 V).

The interface consists of three pins: VBAT, GND and BSI. Pull-down resistor inside of the batteries (BSI signal) recognizes the battery types. Voltage level at BSI line is measured using UEM's AD-converter.

Back-up battery and real time clock

Real time clock (RTC), crystal oscillator and back-up battery circuitry reside in UEM. A register in UEM controls back-up battery charging and charging is possible only in POWER_ON State.

Baseband measurement A/D converter

UEM contains 11 channels A/D converter, which is used for different Baseband measurement purposes. The resolution of A/D converter is 10 bits. Converter uses the CBUS interface clock signal for the conversion. An interrupt will be given to the MCU at the end of the measurements. The Converter is used for following purposes.

- Battery Voltage Measurement A/D Channel (Internal)
- Charger Voltage Measurement A/D Channel (Internal)
- Charger Current Measurement A/D Channel (Internal)
- Battery Temperature Measurement A/D Channel (External)
- Battery Size Measurement A/D Channel (External)
- LED Temperature measurement A/D Channel (External)

There is also auxiliary AD converter in UEM, which is used to monitor RF functions.

ZOCUS

The ZOCUS device is a current sensor used for the battery bar display and for determining whether the phone is in a high current consuming mode. The ZOCUS device measures the voltage drop across a sense resistor in the battery voltage line. This sense resistor is

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formed from a PWB track and is on an internal layer of the PWB. The sense resistor must be located close to the battery terminals so that all of the phones current flow through it. The nominal value of the sense resistor is 3.3 mohm. ZOCUS reports the current measurement to UPP_WD2 via the Cbus interface.

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RH-29 BB Features & HW Interfaces

RH-29 BB user interface

UI module interface

The UI-Module consists of the LCD and keymat. The Colour Display resolution is 176 x 208 and backlighting is via 4 white LED's with lightguide. The display is connected to the 1BQ module via an 18 pin plug and socket. The keymat is connected to 1BQ by 20-pin Board-to-Board connector. Interface also includes power rails for keypad backlight. The keymat interface uses GPIO pins of UPP_WD2.

Bluetooth

Bluetooth provides a fully digital link for communication between a master unit and one or more slave units. The system provides a radio link that offers a high degree of flexibility to support various applications and product scenarios. Data and control interface for a low power RF module is provided. Data rate is regulated between the master and the slave.

SIM interface

The SIM interface is located in two chips (UPP_WD2 and UEM). In UEM there is only support for one SIM card. The interfaces support both 1.8 V and 3 V SIM cards. Adjustable SIM regulator (1.8V/3.0V) is located in UEM and can be controlled by SW.

The data communication between the card and the phone is asynchronous half duplex. The clock supplied to the card is 3.25 MHz. The data baud rate is SIM card clock frequency divided by 372 (by default), 64, 32 or 16.

MMC interface

The MMC interface consists of a block in UPP_WD2 plus a level shifting device known as “Lester” and an EMC protection ASIP. The MMC interface comprises 3 lines -clock, data and command and runs at 8.66 MHz. The Lester device also incorporates a 2.85V regulator to power the MMC card.

Use only Multimedia cards (MMC) with this device. Other memory cards, such as Secure Digital (SD) cards, do not fit in the MMC card slot and are not compatible with this device.

Using an incompatible memory card may damage the memory card as well as device, and data stored on the incompatible card may be corrupted.

RH-29 audio concept

RH-29 Audio includes earpiece, microphone, and headset connector and MALT speaker. Audio is based on ASIC's UPP_WD2, UEM and a discrete amplifier for the handsfree speaker known as “boomer”.

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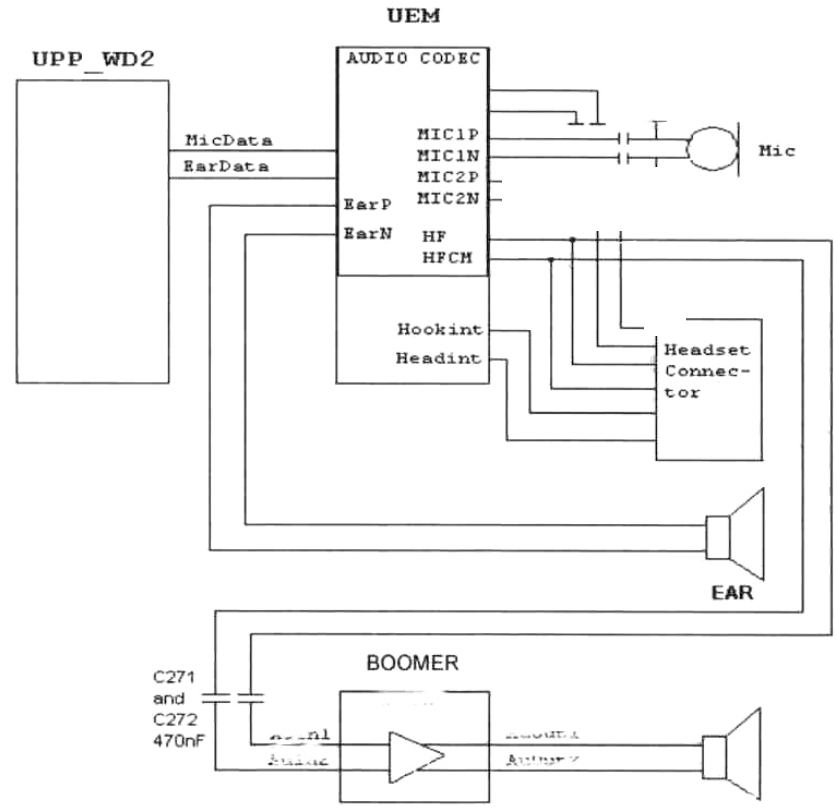
Figure 3: RH-29 Audio Blocks



Between UPP_WD2 and UEM the audio signals are transferred in digital format using signals MICDATA and EARDATA. The headset output of UEM is also fed to boomer i.e. the MALT speaker and the headset share the same output lines from UEM. Ringing tones and warning/info tones are produced with the MALT speaker also.

Earpiece

The earpiece to be used in RH-29 is an 8-mm Pico earpiece produced by Philips Speaker Systems. It has 32Ω continuous impedance and continuous power 8 mWatt. It's driven by differential signals from UEM (EARP & EARN). It makes contact with the PWB via spring contacts.

Microphone

The microphone capsule for RH-29 a BEETLE EMC microphone. It has sensitivity of -42db Nominal. Contacts are done by springs.

Two inputs are used from UEM, one for normal internal microphone and a second for headset. The third microphone input is not used, so it is connected to ground via capacitors. Microphone bias block in UEM generates bias voltages for handportable and hands-Free/headset microphones. For both microphone bias outputs (MICB1 & MICB2) the minimum output voltage is 2.0 Volts and maximum output current is 600 µA. Microphone bias block also includes a low pass filter for the reference voltage used as an input for the MICB1&2 amplifiers.

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Audio amplifier and MALT speaker

The speaker to be used in RH-29 is a 16mm 8Ω speaker. It can handle 0.2 Watts nominal Power and Peak power 0.3 Watts. The component is housed in the B cover and connects to the PWB via spring contacts.

HF and HFCM lines of UEM are use to drive the amplifier.

Power amplifier is a differential opamp. The differential output drives the MALT speaker. The amplifier load impedance is 8 ohm.

The outputs go into a high impedance state when powered down. The amplifier can be enabled and shut down using a GENIO line from UPP_WD2.

SW controls IHF and earpiece volume via UEM. Gain setting can be done in 2 dB steps, from –40 to +6 dB. Output sound pressure level of the MALT speaker is controlled by SW (CBus is used for controlling).

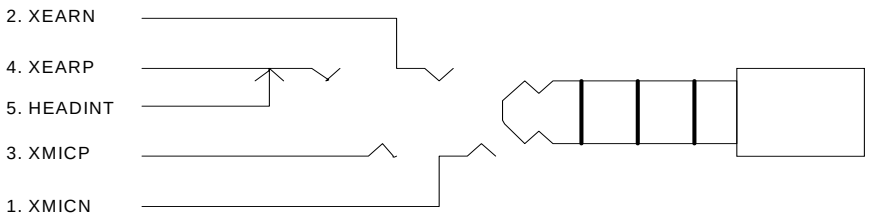
The schematic around the amplifier is presented in RH-29 schematics. The schematic shows all the filtering needed and also protection components against ESD and EMC.EMC and ESD Filtering component must be as near as possible to earphone pads of the phone.

The supply voltage for the amplifier is taken directly from the battery voltage.

External audio interface

In RH-29 there is Headset Connector which is fully differential 4–wire connection.

Figure 4: External Audio Connector



The Handsfree (HF) driver in UEM is meant for headset. In RH-29 case the output is driven in fully differential mode. In the fully differential mode HF pin is the negative output and HFCM pin is the positive output. The gain of the Handsfree driver in the differential mode is 6 dB. The earpiece (EARP, EARN) and headset (HF, HFCM) signals are multiplexed so that the outputs can not be used simultaneously. The HF and HFCM amplifiers include a transient suppression circuitry, which prevents unwanted spikes in HF and HFCM outputs when switching on and off the amplifiers.

The plug will open a mechanical switch inside the connector between HF and HeadInt lines. The HeadInt line will be pulled up to 2.7V by internal resistor when the switch is open. When not having the plug inserted the voltage in the HeadInt line will be <0.8 V caused by internal pull down resistor in the HF line.

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Flashing

SW download in service is implemented by custom tools and SW, kindly refer to Service Software Instructions and Service Tool section of the manual.

Testing interfaces

Testing interface Electrical Specifications

Pin	Name	Dir	Parameter	Min	Typ	Max	Unit	Notes
1	MBUS	<->	Vol	0	0.2	0.3*VFlash1	V	
			Vil (From Prommer)	0	0.2	0.3*VFlash1	V	
			Voh	0.7*VFlash1	2.7	0.7*VFlash1	V	
			Vih(From Prommer)	0.7*VFlash1	2.7	VFlash1	V	
2	FBusTx	->	Vol	0	2.7	0.3*VFlash1	V	
			Voh	0.7*VFlash1	2.7	VFlash1	V	
3	FBusRx	<-	Vil (From Prommer)	0	2.7	0.3*VFlash1	V	
			Vih(FromPrommer)	1.89	2.7	VFlash1	V	
			Abs. Max. Voltage to Test Pad Referenced to GND	-0.3V		3.0	V	Absolute Max Voltage limits to MBUS/ FBUS
4	VPP		To Phone	0 / 2.8 / 12 +/- 3%	V	Prommer Select	4	VPP
4	VPP		To Phone	0 / 2.8 / 12 +/- 3%	V	Prommer Select	4	VPP
5	GND				0		V	VBAT GROUND

Note1: VFlash1 is 2.78 +/- 3%

Electrical Specifications for Power Supply Interface in Prod Testing

Pin	Name	Min	Typ	Max	Unit	Notes
1	VBAT	0	3.6	5.1	V	
2	BSI	0	2.78	VFlash1	V	Internal pullup
3	GND	0			V	

Note 1: VAna & VFlash1 = 2.78 +/-3%

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Extreme voltages

Lithium-Ion battery BL6-C (1 cell):

Nominal voltage is 3.7V

Lower extreme voltage is 2.8V (cut off voltage)

Higher extreme voltage is 4.2V (charging high limit voltage)

Temperature conditions

Specifications are met within range of –10C to +55C ambient temperature. Reduced operation between [-30] and [+60]. Storage temperature range is of –40C to +85C.

Humidity and water resistance

Relative humidity range is 5 ... 95%. Condensed or dripping water may cause intermittent malfunctions. Protection against dripping water have to be implemented in (enclosure) mechanics. Continuous dampness will cause permanent damage to the module.

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RF Characteristics of RH-29

The RF part comprise a multi-band direct conversion transceiver, however, only two bands are used. Using direct conversion no intermediate frequencies are used for up- or down- conversion.

The VCO is set to either twice or four times (depending on the band used) the wanted RX or TX frequency. The VCO frequency is divided by either 2 or 4 and fed to the mixers (down-conversion) or modulators (up-conversion). Up- and down- conversion is done in one step, directly between RF frequency and DC. All up and down-conversion takes place in the RF ASIC named Mjoelner (N601).

Mjoelner RF ASIC also contains PLL and LNAs for all used bands. A DC control section is included to power and/or to control TX buffers, detector and antenna switch. The Mjoelner RF ASIC is controlled via a serial bus.

Mjoelner RF ASIC contains an integrated VCXO which uses an external 26 MHz Xtal. No analogue AFC signal is needed. AFC is done via the serial interface of Mjoelner.

The interface between Mjoelner RF ASIC, UPP and Bluetooth uses a 26 MHz reference clock. An external 26 MHz reference clock buffer is used to drive Bluetooth module.

The RF supports GPRS (General Packed Radio Service), meaning multi-slot operation, this will not require special equipment or procedures in repair situations.

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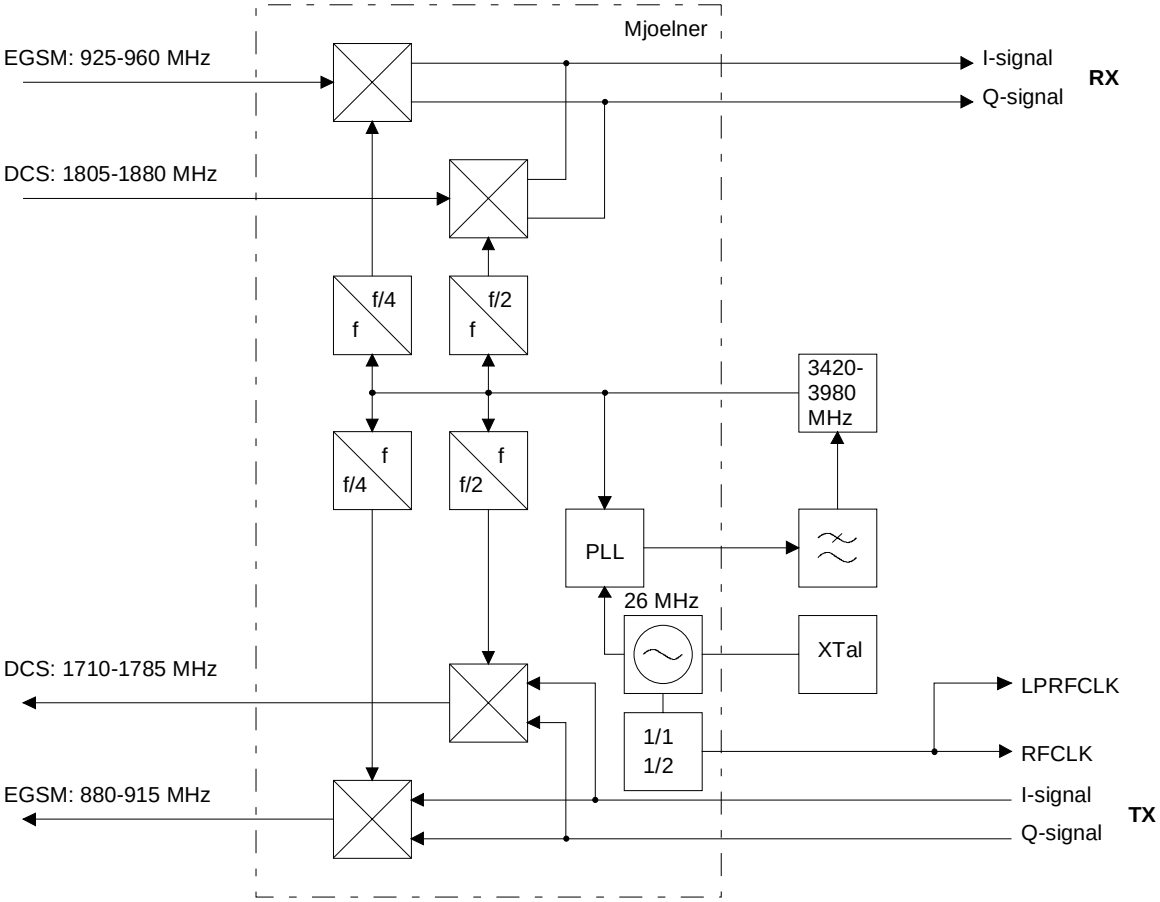
Figure 5: RF frequency plan



RF Power Distribution

All power supplies for the RF Unit are generated in the UEM IC (D190). All RF supplies can be checked either in Mjoelner can or in BB can.

The power supply configuration used is shown in the block diagram below. Values of voltages are given as nominal outputs of UEM. Currents are typical values

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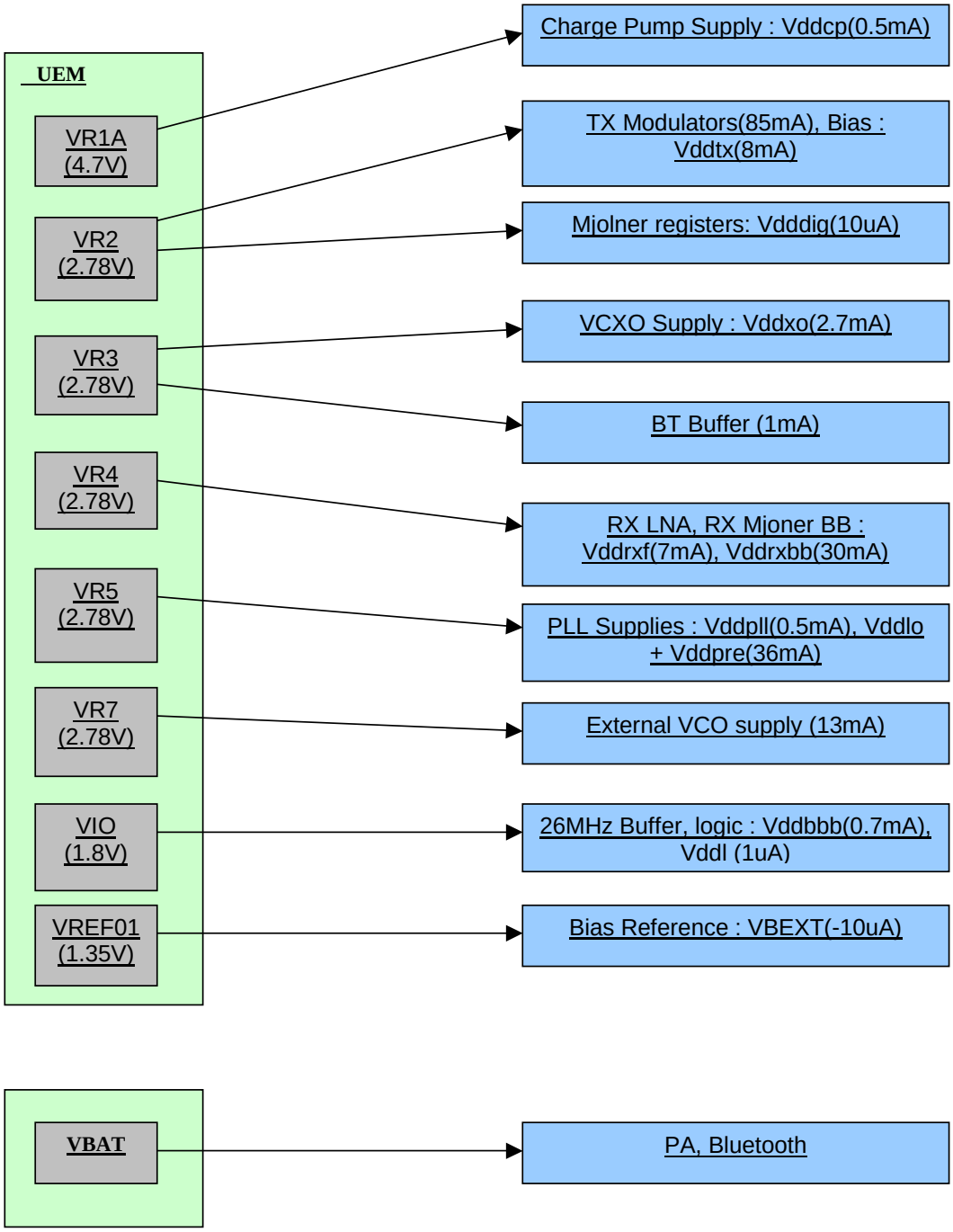
Figure 6: RF Power distribution diagram.



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Channel Numbers and Frequencies

Table 1: GSM900

Frequency list NPL-1 EGSM900														
CH	TX	RX	VCO TX	VCO RX	CH	TX	RX	VCO TX	VCO RX	CH	TX	RX	VCO TX	VCO RX
975	880.2	925.2	3520.8	3700.8	1	890.2	935.2	3560.8	3740.8	63	902.6	947.6	3610.4	3790.4
976	880.4	925.4	3521.6	3701.6	2	890.4	935.4	3561.6	3741.6	64	902.8	947.8	3611.2	3791.2
977	880.6	925.6	3522.4	3702.4	3	890.6	935.6	3562.4	3742.4	65	903.0	948.0	3612.0	3792.0
978	880.8	925.8	3523.2	3703.2	4	890.8	935.8	3563.2	3743.2	66	903.2	948.2	3612.8	3792.8
979	881.0	926.0	3524.0	3704.0	5	891.0	936.0	3564.0	3744.0	67	903.4	948.4	3613.6	3793.6
980	881.2	926.2	3524.8	3704.8	6	891.2	936.2	3564.8	3744.8	68	903.6	948.6	3614.4	3794.4
981	881.4	926.4	3525.6	3705.6	7	891.4	936.4	3565.6	3745.6	69	903.8	948.8	3615.2	3795.2
982	881.6	926.6	3526.4	3706.4	8	891.6	936.6	3566.4	3746.4	70	904.0	949.0	3616.0	3796.0
983	881.8	926.8	3527.2	3707.2	9	891.8	936.8	3567.2	3747.2	71	904.2	949.2	3616.8	3796.8
984	882.0	927.0	3528.0	3708.0	10	892.0	937.0	3568.0	3748.0	72	904.4	949.4	3617.6	3797.6
985	882.2	927.2	3528.8	3708.8	11	892.2	937.2	3568.8	3748.8	73	904.6	949.6	3618.4	3798.4
986	882.4	927.4	3529.6	3709.6	12	892.4	937.4	3569.6	3749.6	74	904.8	949.8	3619.2	3799.2
987	882.6	927.6	3530.4	3710.4	13	892.6	937.6	3570.4	3750.4	75	905.0	950.0	3620.0	3800.0
988	882.8	927.8	3531.2	3711.2	14	892.8	937.8	3571.2	3751.2	76	905.2	950.2	3620.8	3800.8
989	883.0	928.0	3532.0	3712.0	15	893.0	938.0	3572.0	3752.0	77	905.4	950.4	3621.6	3801.6
990	883.2	928.2	3532.8	3712.8	16	893.2	938.2	3572.8	3752.8	78	905.6	950.6	3622.4	3802.4
991	883.4	928.4	3533.6	3713.6	17	893.4	938.4	3573.6	3753.6	79	905.8	950.8	3623.2	3803.2
992	883.6	928.6	3534.4	3714.4	18	893.6	938.6	3574.4	3754.4	80	906.0	951.0	3624.0	3804.0
993	883.8	928.8	3535.2	3715.2	19	893.8	938.8	3575.2	3755.2	81	906.2	951.2	3624.8	3804.8
994	884.0	929.0	3536.0	3716.0	20	894.0	939.0	3576.0	3756.0	82	906.4	951.4	3625.6	3805.6
995	884.2	929.2	3536.8	3716.8	21	894.2	939.2	3576.8	3756.8	83	906.6	951.6	3626.4	3806.4
996	884.4	929.4	3537.6	3717.6	22	894.4	939.4	3577.6	3757.6	84	906.8	951.8	3627.2	3807.2
997	884.6	929.6	3538.4	3718.4	23	894.6	939.6	3578.4	3758.4	85	907.0	952.0	3628.0	3808.0
998	884.8	929.8	3539.2	3719.2	24	894.8	939.8	3579.2	3759.2	86	907.2	952.2	3628.8	3808.8
999	885.0	930.0	3540.0	3720.0	25	895.0	940.0	3580.0	3760.0	87	907.4	952.4	3629.6	3809.6
1000	885.2	930.2	3540.8	3720.8	26	895.2	940.2	3580.8	3760.8	88	907.6	952.6	3630.4	3810.4
1001	885.4	930.4	3541.6	3721.6	27	895.4	940.4	3581.6	3761.6	89	907.8	952.8	3631.2	3811.2
1002	885.6	930.6	3542.4	3722.4	28	895.6	940.6	3582.4	3762.4	90	908.0	953.0	3632.0	3812.0
1003	885.8	930.8	3543.2	3723.2	29	895.8	940.8	3583.2	3763.2	91	908.2	953.2	3632.8	3812.8
1004	886.0	931.0	3544.0	3724.0	30	896.0	941.0	3584.0	3764.0	92	908.4	953.4	3633.6	3813.6
1005	886.2	931.2	3544.8	3724.8	31	896.2	941.2	3584.8	3764.8	93	908.6	953.6	3634.4	3814.4
1006	886.4	931.4	3545.6	3725.6	32	896.4	941.4	3585.6	3765.6	94	908.8	953.8	3635.2	3815.2
1007	886.6	931.6	3546.4	3726.4	33	896.6	941.6	3586.4	3766.4	95	909.0	954.0	3636.0	3816.0
1008	886.8	931.8	3547.2	3727.2	34	896.8	941.8	3587.2	3767.2	96	909.2	954.2	3636.8	3816.8
1009	887.0	932.0	3548.0	3728.0	35	897.0	942.0	3588.0	3768.0	97	909.4	954.4	3637.6	3817.6
1010	887.2	932.2	3548.8	3728.8	36	897.2	942.2	3588.8	3768.8	98	909.6	954.6	3638.4	3818.4
1011	887.4	932.4	3549.6	3729.6	37	897.4	942.4	3589.6	3769.6	99	909.8	954.8	3639.2	3819.2
1012	887.6	932.6	3550.4	3730.4	38	897.6	942.6	3590.4	3770.4	100	910.0	955.0	3640.0	3820.0
1013	887.8	932.8	3551.2	3731.2	39	897.8	942.8	3591.2	3771.2	101	910.2	955.2	3640.8	3820.8
1014	888.0	933.0	3552.0	3732.0	40	898.0	943.0	3592.0	3772.0	102	910.4	955.4	3641.6	3821.6
1015	888.2	933.2	3552.8	3732.8	41	898.2	943.2	3592.8	3772.8	103	910.6	955.6	3642.4	3822.4
1016	888.4	933.4	3553.6	3733.6	42	898.4	943.4	3593.6	3773.6	104	910.8	955.8	3643.2	3823.2
1017	888.6	933.6	3554.4	3734.4	43	898.6	943.6	3594.4	3774.4	105	911.0	956.0	3644.0	3824.0
1018	888.8	933.8	3555.2	3735.2	44	898.8	943.8	3595.2	3775.2	106	911.2	956.2	3644.8	3824.8
1019	889.0	934.0	3556.0	3736.0	45	899.0	944.0	3596.0	3776.0	107	911.4	956.4	3645.6	3825.6
1020	889.2	934.2	3556.8	3736.8	46	899.2	944.2	3596.8	3776.8	108	911.6	956.6	3646.4	3826.4
1021	889.4	934.4	3557.6	3737.6	47	899.4	944.4	3597.6	3777.6	109	911.8	956.8	3647.2	3827.2
1022	889.6	934.6	3558.4	3738.4	48	899.6	944.6	3598.4	3778.4	110	912.0	957.0	3648.0	3828.0
1023	889.8	934.8	3559.2	3739.2	49	899.8	944.8	3599.2	3779.2	111	912.2	957.2	3648.8	3828.8
0	890.0	935.0	3560.0	3740.0	50	900.0	945.0	3600.0	3780.0	112	912.4	957.4	3649.6	3829.6
					51	900.2	945.2	3600.8	3780.8	113	912.6	957.6	3650.4	3830.4
					52	900.4	945.4	3601.6	3781.6	114	912.8	957.8	3651.2	3831.2
					53	900.6	945.6	3602.4	3782.4	115	913.0	958.0	3652.0	3832.0
					54	900.8	945.8	3603.2	3783.2	116	913.2	958.2	3652.8	3832.8
					55	901.0	946.0	3604.0	3784.0	117	913.4	958.4	3653.6	3833.6
					56	901.2	946.2	3604.8	3784.8	118	913.6	958.6	3654.4	3834.4
					57	901.4	946.4	3605.6	3785.6	119	913.8	958.8	3655.2	3835.2
					58	901.6	946.6	3606.4	3786.4	120	914.0	959.0	3656.0	3836.0
					59	901.8	946.8	3607.2	3787.2	121	914.2	959.2	3656.8	3836.8
					60	902.0	947.0	3608.0	3788.0	122	914.4	959.4	3657.6	3837.6
					61	902.2	947.2	3608.8	3788.8	123	914.6	959.6	3658.4	3838.4
					62	902.4	947.4	3609.6	3789.6	124	914.8	959.8	3659.2	3839.2

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Table 2: DCS1800

Table 3:

CH	TX	RX	VCO TX	VCO RX	CH	TX	RX	VCO TX	VCO RX	CH	TX	RX	VCO TX	VCO RX	CH	TX	RX	VCO TX	VCO RX
512	1710.2	1805.2	3420.4	3610.4	606	1729.0	1824.0	3458.0	3648.0	700	1747.8	1842.8	3495.6	3685.6	794	1766.6	1861.6	3533.2	3723.2
513	1710.4	1805.4	3420.8	3610.8	607	1729.2	1824.2	3458.4	3648.4	701	1748.0	1843.0	3496.0	3686.0	795	1766.8	1861.8	3533.6	3723.6
514	1710.6	1805.6	3421.2	3611.2	608	1729.4	1824.4	3458.8	3648.8	702	1748.2	1843.2	3496.4	3686.4	796	1767.0	1862.0	3534.0	3724.0
515	1710.8	1805.8	3421.6	3611.6	609	1729.6	1824.6	3459.2	3649.2	703	1748.4	1843.4	3496.8	3686.8	797	1767.2	1862.2	3534.4	3724.4
516	1711.0	1806.0	3422.0	3612.0	610	1729.8	1824.8	3459.6	3649.6	704	1748.6	1843.6	3497.2	3687.2	798	1767.4	1862.4	3534.8	3724.8
517	1711.2	1806.2	3422.4	3612.4	611	1730.0	1825.0	3460.0	3650.0	705	1748.8	1843.8	3497.6	3687.6	799	1767.6	1862.6	3535.2	3725.2
518	1711.4	1806.4	3422.8	3612.8	612	1730.2	1825.2	3460.4	3650.4	706	1749.0	1844.0	3498.0	3688.0	800	1767.8	1862.8	3535.6	3725.6
519	1711.6	1806.6	3423.2	3613.2	613	1730.4	1825.4	3460.8	3650.8	707	1749.2	1844.2	3498.4	3688.4	801	1768.0	1863.0	3536.0	3726.0

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Table 3:

520	1711.8	18068	3423.6	3613.6	614	17306	18256	3461.2	3651.2	708	17494	18444	3498.8	3688.8	802	1768.2	1863.2	3536.4	3726.4
521	1712.0	18070	3424.0	3614.0	615	17308	18258	3461.6	3651.6	709	17496	18446	3499.2	3689.2	803	1768.4	1863.4	3536.8	3726.8
522	1712.2	18072	3424.4	3614.4	616	17310	18260	3462.0	3652.0	710	17498	18448	3499.6	3689.6	804	1768.6	1863.6	3537.2	3727.2
523	1712.4	18074	3424.8	3614.8	617	17312	18262	3462.4	3652.4	711	17500	18450	3500.0	3690.0	805	1768.8	1863.8	3537.6	3727.6
524	1712.6	18076	3425.2	3615.2	618	17314	18264	3462.8	3652.8	712	17502	18452	3500.4	3690.4	806	1769.0	1864.0	3538.0	3728.0
525	1712.8	18078	3425.6	3615.6	619	17316	18266	3463.2	3653.2	713	17504	18454	3500.8	3690.8	807	1769.2	1864.2	3538.4	3728.4
526	1713.0	18080	3426.0	3616.0	620	17318	18268	3463.6	3653.6	714	17506	18456	3501.2	3691.2	808	1769.4	1864.4	3538.8	3728.8
527	1713.2	18082	3426.4	3616.4	621	17320	18270	3464.0	3654.0	715	17508	18458	3501.6	3691.6	809	1769.6	1864.6	3539.2	3729.2
528	1713.4	18084	3426.8	3616.8	622	17322	18272	3464.4	3654.4	716	17510	18460	3502.0	3692.0	810	1769.8	1864.8	3539.6	3729.6

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Table 3:

529	1713.6	1808.6	3427.2	3617.2	623	1732.4	1827.4	3464.8	3654.8	717	1751.2	1846.2	3502.4	3692.4	811	1770.0	1865.0	3540.0	3730.0
530	1713.8	1808.8	3427.6	3617.6	624	1732.6	1827.6	3465.2	3655.2	718	1751.4	1846.4	3502.8	3692.8	812	1770.2	1865.2	3540.4	3730.4
531	1714.0	1809.0	3428.0	3618.0	625	1732.8	1827.8	3465.6	3655.6	719	1751.6	1846.6	3503.2	3693.2	813	1770.4	1865.4	3540.8	3730.8
532	1714.2	1809.2	3428.4	3618.4	626	1733.0	1828.0	3466.0	3656.0	720	1751.8	1846.8	3503.6	3693.6	814	1770.6	1865.6	3541.2	3731.2
533	1714.4	1809.4	3428.8	3618.8	627	1733.2	1828.2	3466.4	3656.4	721	1752.0	1847.0	3504.0	3694.0	815	1770.8	1865.8	3541.6	3731.6
534	1714.6	1809.6	3429.2	3619.2	628	1733.4	1828.4	3466.8	3656.8	722	1752.2	1847.2	3504.4	3694.4	816	1771.0	1866.0	3542.0	3732.0
535	1714.8	1809.8	3429.6	3619.6	629	1733.6	1828.6	3467.2	3657.2	723	1752.4	1847.4	3504.8	3694.8	817	1771.2	1866.2	3542.4	3732.4
536	1715.0	1810.0	3430.0	3620.0	630	1733.8	1828.8	3467.6	3657.6	724	1752.6	1847.6	3505.2	3695.2	818	1771.4	1866.4	3542.8	3732.8
537	1715.2	1810.2	3430.4	3620.4	631	1734.0	1829.0	3468.0	3658.0	725	1752.8	1847.8	3505.6	3695.6	819	1771.6	1866.6	3543.2	3733.2

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Table 3:

538	1715.4	1810.4	3430.8	3620.8	632	1734.2	1829.2	3468.4	3658.4	726	1753.0	1848.0	3506.0	3696.0	820	1771.8	1866.8	3543.6	3733.6
539	1715.6	1810.6	3431.2	3621.2	633	1734.4	1829.4	3468.8	3658.8	727	1753.2	1848.2	3506.4	3696.4	821	1772.0	1867.0	3544.0	3734.0
540	1715.8	1810.8	3431.6	3621.6	634	1734.6	1829.6	3469.2	3659.2	728	1753.4	1848.4	3506.8	3696.8	822	1772.2	1867.2	3544.4	3734.4
541	1716.0	1811.0	3432.0	3622.0	635	1734.8	1829.8	3469.6	3659.6	729	1753.6	1848.6	3507.2	3697.2	823	1772.4	1867.4	3544.8	3734.8
542	1716.2	1811.2	3432.4	3622.4	636	1735.0	1830.0	3470.0	3660.0	730	1753.8	1848.8	3507.6	3697.6	824	1772.6	1867.6	3545.2	3735.2
543	1716.4	1811.4	3432.8	3622.8	637	1735.2	1830.2	3470.4	3660.4	731	1754.0	1849.0	3508.0	3698.0	825	1772.8	1867.8	3545.6	3735.6
544	1716.6	1811.5	3433.2	3623.2	638	1735.4	1830.4	3470.8	3660.8	732	1754.2	1849.2	3508.4	3698.4	826	1773.0	1868.0	3546.0	3736.0
545	1716.8	1811.8	3433.6	3623.6	639	1735.6	1830.6	3471,2	3661.2	733	1754.4	1849.4	3508.8	3698.8	827	1773.2	1868.2	3546.4	3736.4
546	1717.0	1812.0	3434.0	3624.0	640	1735.8	1830.8	3471.6	3661.6	734	1754.6	1849.6	3509.2	3699.2	828	1773.4	1868.4	3546.8	3736.8

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Table 3:

547	1717.2	18122	3434.4	3624.4	641	17360	18310	3472.0	3662.0	735	17548	18498	3509.6	3699.6	829	1773.6	1868.6	3547.2	3737.2
548	1717.4	18124	3434.8	3624.8	642	17362	18312	3472.4	3662.4	736	17550	18500	3510.0	3700.0	830	1773.8	1868.8	3547.6	3737.6
549	1717.6	18126	3435.2	3625.2	643	17364	18314	3472.8	3662.8	737	17552	18502	3510.4	3700.4	831	1774.0	1869.0	3548.0	3738.0
550	1717.8	18128	3435.6	3625.6	644	17366	18316	3473.2	3663.2	738	17554	18504	3510.8	3700.8	832	1774.2	1869.2	3548.4	3738.4
551	1718.0	18130	3436.0	3626.0	645	17368	18318	3473.6	3663.6	739	17556	18506	3511.2	3701.2	833	1774,4	1869.4	3548.8	3738.8
552	1718.2	18132	3436.4	3626.4	646	17370	18320	3474.0	3664.0	740	17558	18508	3511.6	3701.6	834	1774.6	1869.6	3549.2	3739.2
553	1718.4	18134	3436.8	3626.8	647	17372	18322	3474.4	3664.4	741	17560	18510	3512.0	3702.0	835	1774.8	1869.8	3549.6	3739.6
554	1718.6	18136	3437.2	3627.2	648	17374	18324	3474.8	3664.8	742	17562	18512	3512.4	3702.4	836	1775.0	1870.0	3550.0	3740.0
555	1718.8	18138	3437.6	3627.6	649	17376	18326	3475.2	3665.2	743	17564	18514	3512.8	3702.8	837	1775.2	1870.2	3550.4	3740.4

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Table 3:

556	1719.0	1814.0	3438.0	3628.0	650	1737.8	1832.8	3475.6	3665.6	754	1756.6	1851.6	3513.2	3703.2	838	1775.4	1870.4	3550.8	3740.8
557	1719.2	1814.2	3438.4	3628.4	651	1738.0	1833.0	3476.0	3666.0	745	1756.8	1851.8	3513.6	3703.6	839	1775.6	1870.6	3551.2	3741.2
558	1719.4	1814.4	3438.8	3628.8	652	1738.2	1833.2	3476.4	3666.4	746	1757.0	1852.0	3514.0	3704.0	840	1775.8	1870.8	3551.6	3741.6
559	1719.6	1814.6	3449.2	3629.2	653	1738.4	1833.4	3476.8	3666.8	747	1757.2	1852.2	3514.4	3704.4	841	1776.0	1871.0	3552.0	3742.0
560	1719.8	1814.8	3449.6	3629.6	654	1738.6	1833.6	3477.2	3667.2	748	1757.4	1852.4	3514.8	3704.8	842	1776.2	1871.2	3552.4	3742.4
561	1720.0	1815.0	3440.0	3630.0	655	1738.8	1833.8	3477.6	3667.6	749	1757.6	1852.6	3515.2	3705.2	843	1776.4	1871.4	3552.8	3742.8
562	1720.2	1815.2	3440.4	3630.4	656	1739.0	1834.0	3478.0	3668.0	750	1757.8	1852.8	3515.6	3705.6	844	1776.6	1871.6	3553.2	3743.2
563	1720.4	1815.4	3440.8	3630.8	657	1739.2	1834.2	3478.4	3668.4	751	1758.0	1853.0	3516.0	3706.0	845	1776.8	1871.8	3553.6	3743.6
564	1720.6	1815.6	3441.2	3631.2	658	1739.4	1834.4	3478.8	3668.8	752	1758.2	1853.2	3516.4	3706.4	846	1777.0	1872.0	3554.0	3744.0

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Table 3:

565	1720.8	1815.8	3441.6	3631.6	659	1739.6	1834.6	3479.2	3669.2	753	1758.4	1853.4	3516.8	3706.8	847	1777.2	1872.2	3554.4	3744.4
566	1721.0	1816.0	3442.0	3632.0	660	1739.8	1834.8	3479.6	3669.6	754	1758.6	1853.6	3517.2	3707.2	848	1777.4	1872.4	3554.8	3744.8
567	1721.2	1816.2	3442.4	3632.4	661	1740.0	1835.0	3480.0	3670.0	755	1758.8	1853.8	3517.6	3707.6	849	1777.6	1872.6	3555.2	3745.2
568	1721.4	1816.4	3442.8	3632.8	662	1740.2	1835.2	3480.4	3670.4	756	1759.0	1854.0	3518.0	3708.0	850	1777.8	1872.8	3555.6	3745.6
569	1721.6	1816.6	3443.2	3633.2	663	1740.4	1835.4	3480.8	3670.8	757	1759.2	1854.2	3518.4	3708.4	851	1778.0	1873.0	3556.0	3746.0
570	1721.8	1816.8	3443.6	3633.6	664	1740.6	1835.6	3481.2	3671.2	758	1759.4	1854.4	3518.8	3708.8	852	1778.2	1873.2	3556.4	3746.4
571	1722.0	1817.0	3444.0	3634.0	665	1740.8	1835.8	3481.6	3671.6	759	1759.6	1854.6	3519.2	3709.2	853	1778.4	1873.4	3556.8	3746.8
572	1722.2	1817.2	3444.4	3634.4	666	1741.0	1836.0	3482.0	3672.0	760	1759.8	1854.8	3519.6	3709.6	854	1778.6	1873.6	3557.2	3747.2
573	1722.4	1817.4	3444.8	3634.8	667	1741.2	1836.2	3482.4	3672.4	761	1760.0	1855.0	3520.0	3710.0	855	1778.8	1873.8	3557.6	3747.6

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Table 3:

574	17222.6	18176	3445.2	3635.2	668	17414	18364	3482.8	3672.8	762	17602	18552	3520.4	3710.4	856	1779.0	1874.0	3558.0	3748.0
575	17222.8	18178	3445.6	3635.6	669	17416	18366	3483.2	3673.2	763	17604	18554	3520.8	3710.8	857	1779.2	1874.2	3558.4	3748.4
576	17223.0	18180	3446.0	3636.0	670	17418	18368	3483.6	3673.6	764	17606	18556	3521.2	3711.2	858	1779.4	1874.4	3558.8	3748.8
577	17223.2	18182	3446.4	3636.4	671	17420	18370	3484.0	3674.0	765	17608	18558	3521.6	3711.6	859	1779.6	1874.6	3559.2	3749.2
578	17223.4	18184	3446.8	3636.8	672	17422	18372	3484.4	3674.4	766	17610	18560	3522.0	3712.0	860	1779.8	1874.8	3559.6	3749.6
579	17223.6	18186	3447.2	3637.2	673	17424	18374	3484.8	3674.8	767	17612	18562	3522.4	3712.4	861	1780.0	1875.0	3560.0	3750.0
580	17223.8	18188	3447.6	3637.6	674	17426	18376	3485.2	3675.2	768	17614	18564	3522.8	3712.8	862	1780.2	1875.2	3560.4	3750.4
581	17224.0	18190	3448.0	3638.0	675	17428	18378	3485.6	3675.6	769	17616	18566	3523.2	3713.2	863	1780.4	1875.4	3560.8	3750.8
582	17224.2	18192	3448.4	3638.4	676	17430	18380	3486.0	3676.0	770	17618	18568	3523.6	3713.6	864	1780.6	1875.6	3561.2	3751.2

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Table 3:

583	17244	18194	3448	3638	677	17432	18382	3486	3676	771	17620	18570	3524	3714	865	1780	1875	3561	3751
584	17246	18196	3449	3639	678	17434	18384	3486	3676	772	17622	18572	3524	3714	866	1781	1876	3562	3752
585	17248	18198	3449	3639	679	17436	18386	3487	3677	773	17624	18574	3524	3714	867	1781	1876	3562	3752
586	17250	18200	3450	3640	680	17438	18388	3487	3677	774	17626	18576	3525	3715	868	1781	1876	3562	3752
587	17252	18202	3450	3640	681	17440	18390	3488	3678	775	17628	18578	3525	3715	869	1781	1876	3563	3753
588	17254	18204	3450	3640	682	17442	18392	3488	3678	776	17630	18580	3526	3716	870	1781	1876	3563	3753
589	17256	18206	3451	3641	683	17444	18394	3488	3678	777	17632	18582	3526	3716	871	1782	1877	3564	3754
590	17258	18208	3451	3641	684	17446	18396	3489	3679	778	17634	18584	3526	3716	872	1782	1877	3564	3754
591	17260	18210	3452	3642	685	17448	18398	3489	3679	779	17636	18586	3527	3717	873	1782	1877	3564	3754

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Table 3:

592	17262	18212	3452.4	3642.4	686	17450	18400	3490.0	3680.0	780	17638	18588	3527.6	3717.6	874	1782.6	1877.6	3565.2	3755.2
593	17264	18214	3452.8	3642.8	687	17452	18402	3490.4	3680.4	781	17640	18590	3528.0	3718.0	875	1782.8	1877.8	3565.6	3755.6
594	17266	18216	3453.2	3643.2	688	17454	18404	3490.8	3680.8	782	17642	18592	3528.4	3718.4	876	1783.0	1878.0	3566.0	3756.0
595	17268	18218	3453.6	3643.6	689	17456	18406	3491.2	3681.2	783	17644	18594	3528.8	3718.8	877	1783.2	1878.2	3566.4	3756.4
596	17270	18220	3454.0	3644.0	690	17458	18408	3491.6	3681.6	784	17646	18596	3529.2	3719.2	878	1783.4	1878.4	3566.8	3756.8
597	17272	18222	3454.4	3644.4	691	17460	18410	3492.0	3682.0	785	17648	18598	3529.6	3719.6	879	1783.6	1878.6	3567.2	3757.2
598	17274	18224	3454.8	3644.8	692	17462	18412	3492.4	3682.4	786	17650	18600	3530.0	3720.0	880	1783.8	1878.8	3567.6	3757.6
599	17276	18226	3455.2	3645.2	693	17464	18414	3492.8	3682.8	787	17652	18602	3530.4	3720.4	881	1784.0	1879.0	3568.0	3758.0
600	17278	18228	3455.6	3645.6	694	17466	18416	3493.2	3683.2	788	17654	18604	3530.8	3720.8	882	1784.2	1879.2	3568.4	3758.4

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Table 3:

601	17280	18230	3456.0	3646.0	695	17468	1841.8	3493.6	3683.6	789	17655.6	1860.6	3531.2	3721.2	883	1784.4	1879.4	3568.8	3758.8
602	17282	18232	3456.4	3646.4	696	17470	1842.0	3494.0	3684.0	790	17658	1860.8	3531.6	3721.6	884	1784.6	1879.6	3569.2	3759.2
603	17284	18234	3456.8	3646.8	697	17472	1842.2	3494.4	3684.4	791	17660	1861.0	3532.0	3722.0	885	1784.8	1879.8	3569.6	3759.6
604	17286	18236	3457.2	3647.2	698	17474	1842.4	3494.8	3684.8	792	17662	1861.2	3532.4	3722.4					
605	17288	18238	3457.6	3647.6	699	17476	1842.6	3495.2	3685.2	793	17664	1861.4	3532.8	3722.8					

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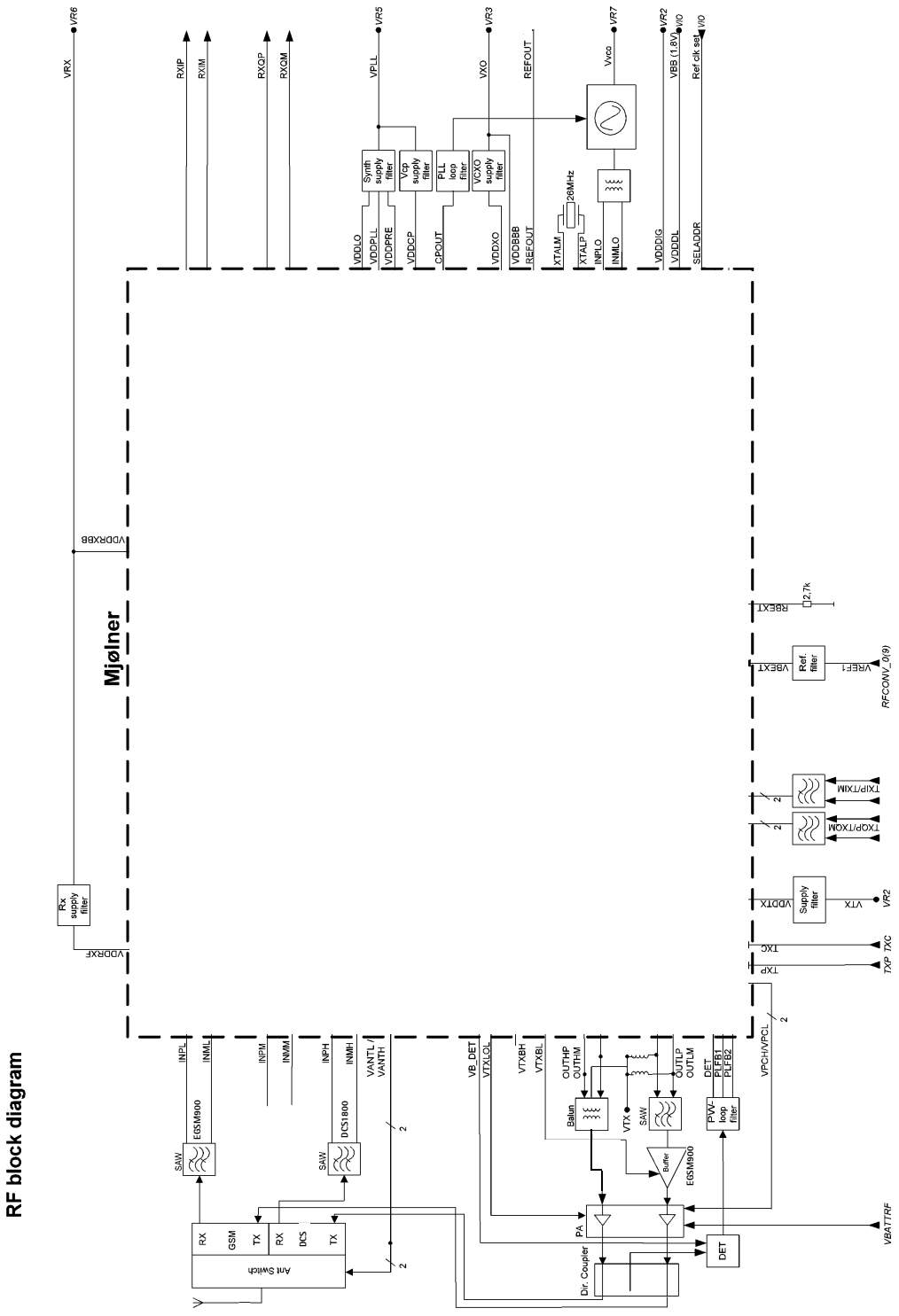
RF block diagram

Figure 7: RF block diagram



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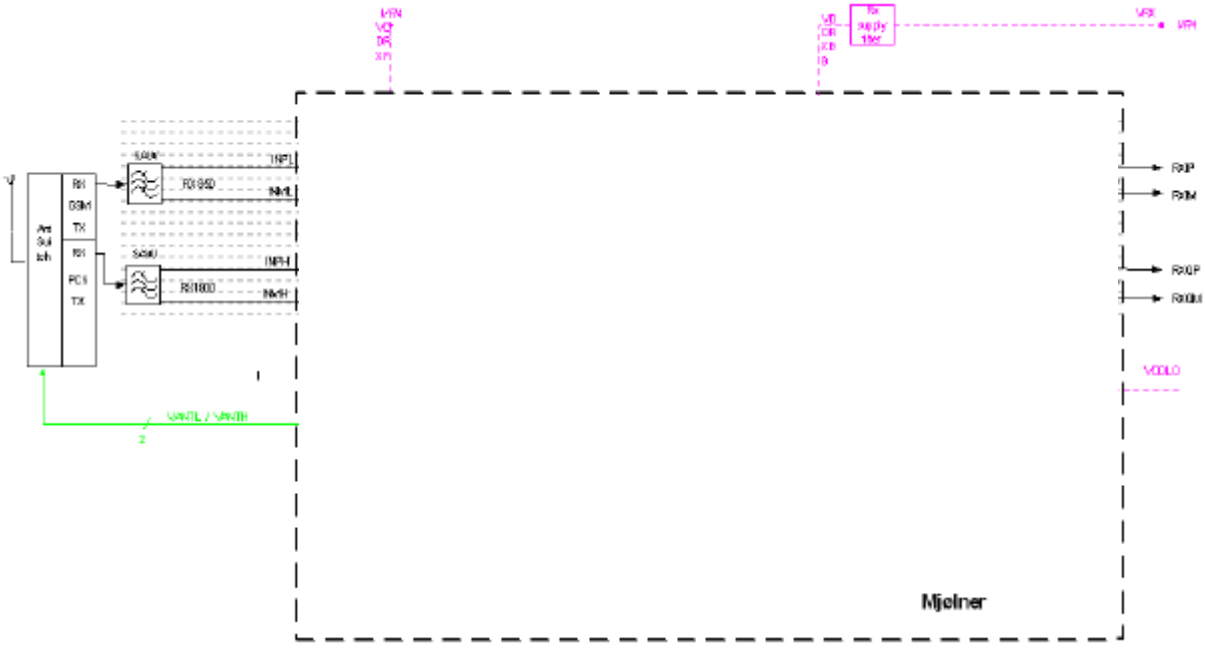
Receiver

Rx Signal paths

The signal paths of the receiver are shown in following block diagram. Note that the picture shows GSM900 receiver (top) and GSM1800 (DCS) receiver (down).



Antenna switch

RH-29 has no antenna connector. The antenna is connected via the antenna fed point X810.

The RX/TX switch (Z601) works as a diplexer.

From the antenna-pad (X602), the RF signal is fed through a bypass capacitor (C650) to the RX/TX switch (Z601).

The RX/TX switch with routed lines has following maximum insertion losses for both EGSM900 and DCS1800:

RX 1.0dB

TX 1.25dB

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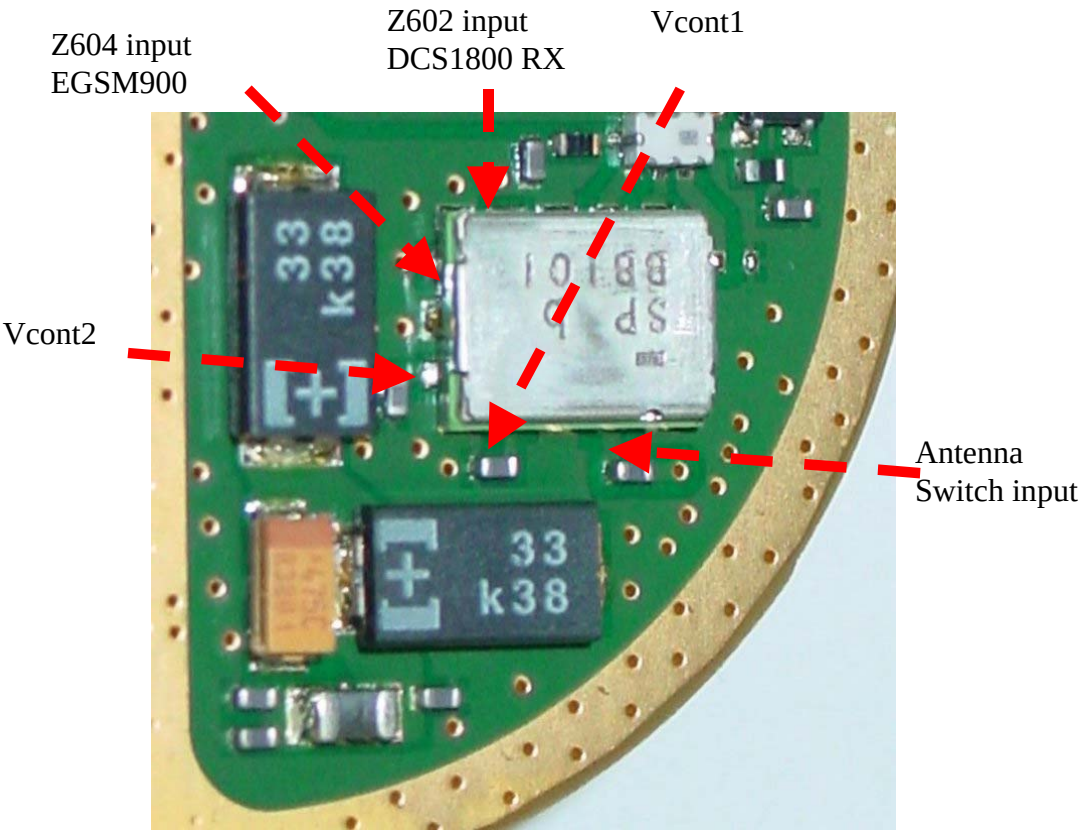
Figure 8: Antenna switch Rx test points



Receiver

The RX front end includes two SAW filters (GSM900 (Z604) and GSM1800 (Z602)). Each of the SAW filters is matched with a differential matching circuit (LC-type) to the corresponding LNA input of Mjoelner RF ASIC (N601). The SAW filters provide out-of-band blocking immunity, the integrated LNAs provide the front-end gains. Each of the SAW filters has a single-ended input and a balanced output which provides a balanced RX signal to the corresponding input of the Mjoelner RF ASIC.

The SAW filters have maximum insertion losses of

3.5dB@GSM900 and 4.0dB@GSM1800.

The balanced RX signal is amplified by the integrated LNA and the subsequent Pre-Gain stage. After amplification the RX signal is down-converted with a LO signal coming from the local oscillator.

The RX paths of Mjoelner RF ASIC consist of following building blocks:

- Separate LNAs for each band: GSM900 and GSM1800.
- Two PREGAIN amplifiers, one for GSM900 and one for GSM1800.
- Two passive I/Q mixers (MIX), one for GSM900 and for GSM1800.

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The resulting BB signal is further amplified in the BB chain. For that no external circuitry is required:

- Base band amplifiers (BBAMP1). That amplifiers implement the initial channel filtering.
- Low pass filters (LPF1).
- DC compensation / AGC amplifiers (DCN1). They implement gain steps from 0dB to 24dB in 6dB steps.
- Attenuators (AGC). They implement gain steps from -48dB to 0dB in 6dB steps, yielding a total gain range of 72dB together with DCN1.
- Bi-quad filters (LPF2).
- DC compensation amplifiers (DCN2).

The differential base band outputs are internally DC coupled and can be connected directly to the ADC inputs of the RF converter chip. The common mode level is set equal to the VBEXT reference voltage.

GSM900 Transmitter

TX Path of the transmitted GSM900 signal

For easy error tracing it is important to know the signal path of the GSM900 transmitter. The components can be grouped into blocks and drawn as shown below. Note that the following picture shows both GSM900 transmitter (bottom) and GSM1800 transmitter

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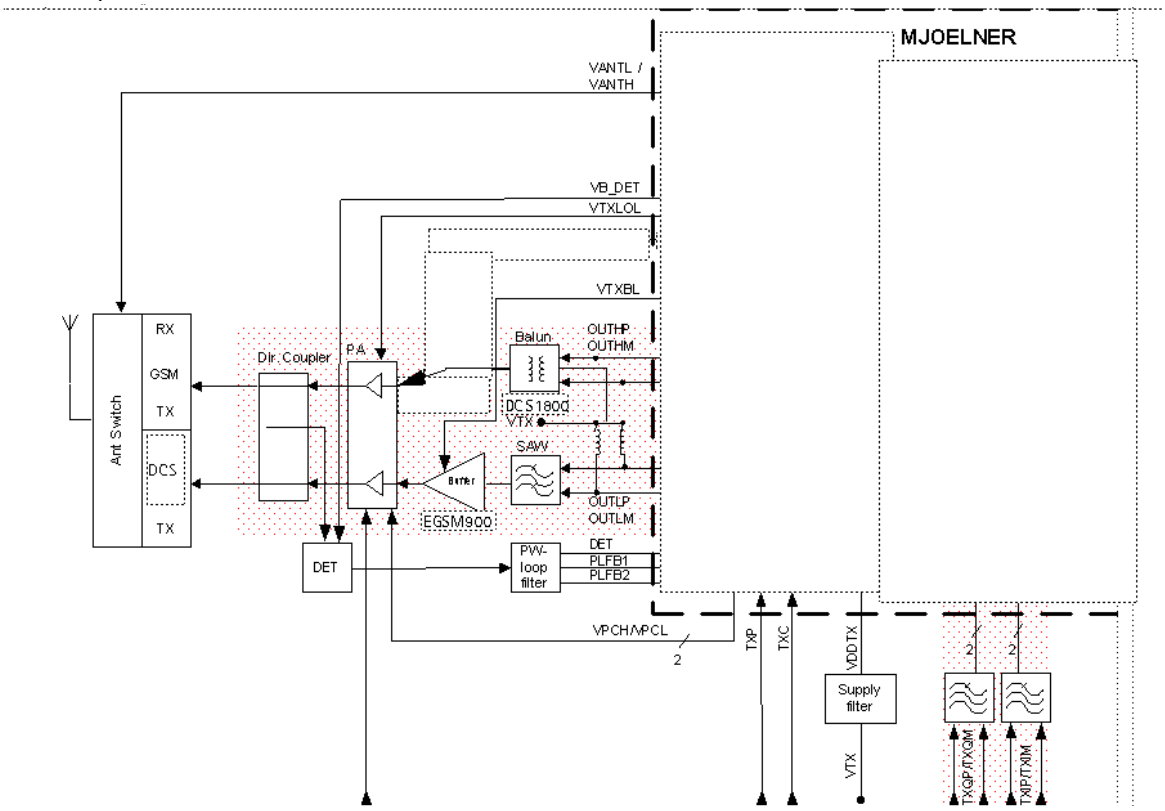
(top).



GSM900 TX path of Mjoelner RF ASIC

The balanced TX signal is provided by the base band and is coming to the Mjoelner RF ASIC. The TX paths of the Mjoelner RF ASIC include mainly two RF modulators for up-conversion of the base band signals, one for GSM900 and one for GSM1800. The base band signal is modulated with the LO signal corresponding to the wanted TX channel. The GSM TX output of the Mjoelner RF ASIC is a balanced signal.

From the output of the Mjoelner RFASIC the signal is fed through the 900 TX SAW filter (Balanced to single ended), the 900 MHz buffer, and a 5 dB pad to the PA input.

GSM900 TX path of the Power Amplifier (PA)

The PA GSM900 part has a minimum stable output power of app. 35 dBm. Voltage supply is coming directly from the Battery connectors.

The GSM900 output is controlled by the power control loop. From the GSM900 output of the PA the RF signal is fed through the directional coupler (one of the power control loop components) to the antenna switch.

Antenna Switch (TX/RX switch)

The antenna Switch works as a diplexer for the RX and TX signals. Moreover, it suppresses the TX harmonics generated by the PA. The antenna switch is controlled by the Mjoelner RF ASIC using the control signals Vcont1 and Vcont2. The following table

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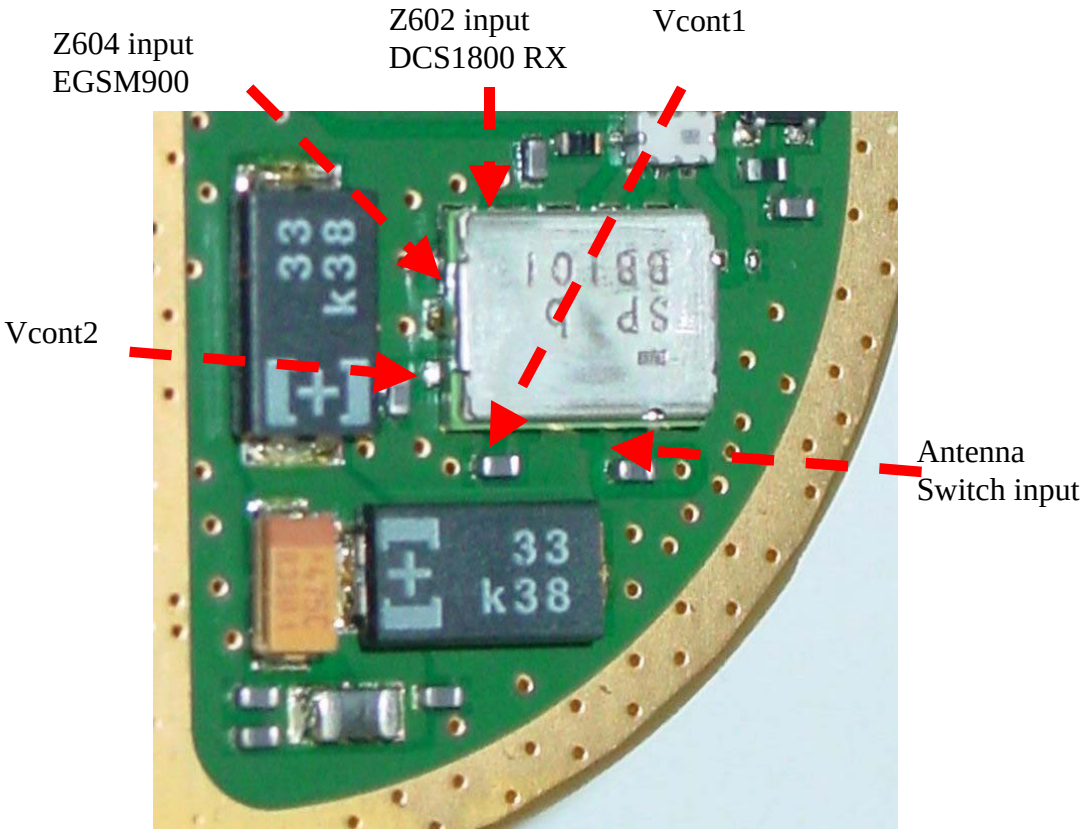
shows the possible different states.

Vcont1 [Volt]	Vcont2 [Volt]	900 Rx	DCS Rx	900 Tx	DCS Tx
0	0	X			
0	0		X		
0	2.7			X	
2.7	0				X

Figure 9: Antenna Switch Test Points



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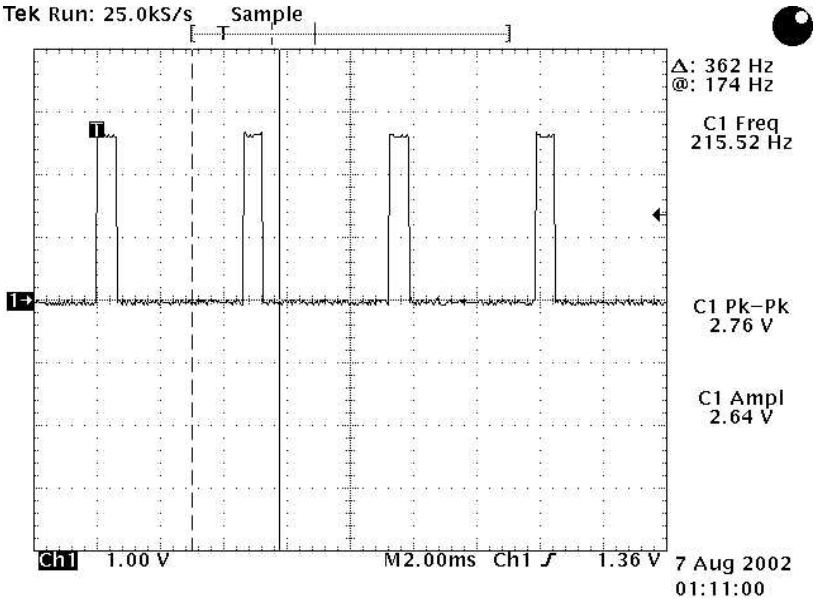
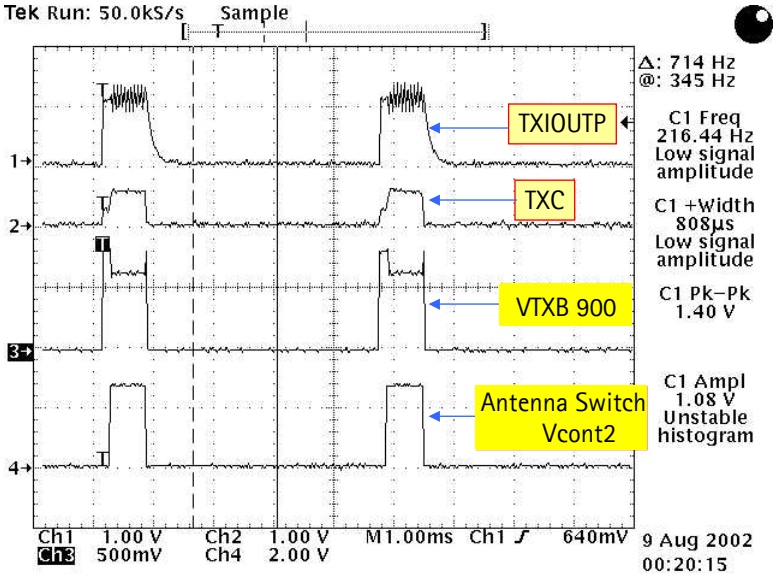
Antenna Switch Control Line During GSM900 Transmission



Transmit Timing



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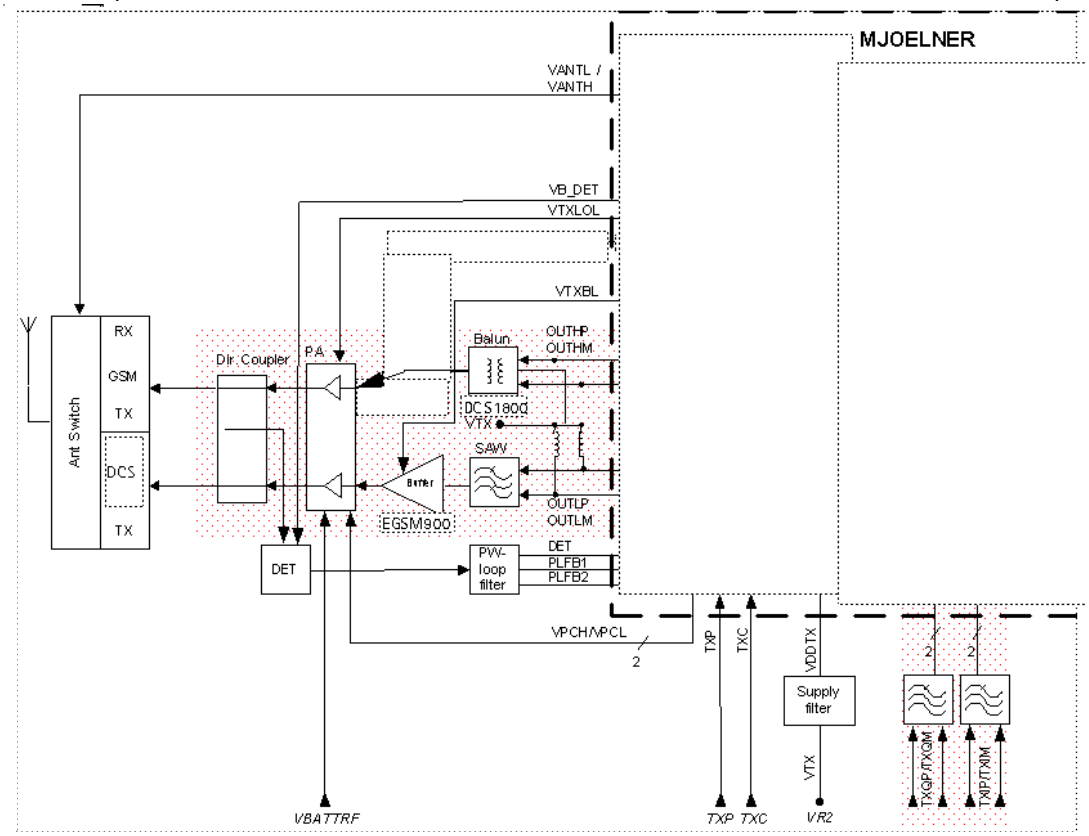
GSM1800 Transmitter

Path of the transmitted 1800 signal

For easy error tracking it is important to know the signal path of the GSM1800 transmitter. The components can be grouped into blocks and drawn as shown below. Note that the picture shows both 900 transmitter (bottom) and GSM1800 transmitter (top).



The path of Mjoelner RF ASIC

The balanced TX signal from base band is coming to Mjoelner RF ASIC. The GSM1800 path includes a RF modulator for GSM1800. The BB signal is up-converted with the LO signal corresponding to the wanted TX channel. The GSM1800 TX output of Mjoelner is a balanced signal.

From the output of Mjoelner the signal is fed through the Balun T701 (Balanced to single ended) and a 3 dB pad.

The path of the PA

The GSM1800 part of the PA has a maximum output of approximately 33dBm. The supply is coming directly from the Battery connectors.

The output is controlled by the power control loop. From the output of the PA the signal goes through the directional coupler (one of the power control loop components) to the Antenna Switch.

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Antenna Switch

The Antenna Switch works as a diplexer between RX and TX Bands. Moreover, it partly suppresses the harmonics generated by the PA. Mjoelner RF ASIC controls the antenna switch by two voltages Vcont1 and Vcont2. The following table shows the different states.

Vcont1 [Volt]	Vcont2 [Volt]	900 Rx	DCS Rx	900 Tx	DCS Tx
0	0	X			
0	0		X		
0	2.7			X	
2.7	0				X

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Synthesizer

There is only one PLL synthesizer generating frequencies for both Rx and Tx for all three bands. VCO frequency is divided by 2 or by 4 in Mjoelner depending on which band is active.

26 MHz reference oscillator (VCXO)

The 26 MHz reference oscillator (VCXO) is part of Mjoelner RF-ASIC (N601). It needs only an external 26 MHz Xtal (B601) as external circuitry.

The reference oscillator has three functions:

- Reference frequency for the PLL synthesizer.
- System clock for BB (RFClk_I = 26 MHz).
- 26 MHz Reference clock (LPRFClk_I) for Bluetooth Module (N430) via buffer V601.

For an error free initial synchronization, the 26MHz frequency of the VCXO must be accurate enough. Therefore, a **VCXO-calibration (cal)** value is written via the serial Bus into the RefOSCCAL register of Mjoelner and an additional bit in the RefOSCCntl register of the Mjoelner. That is necessary for the rough calibration of the VCXO.

The VCXO is fine tuned by programming the AFC value via the serial bus of Mjoelner. The necessary AFC value is written into the RefOSCAFC register in Mjoelner.

VCO

The VCO is able to generate frequencies in the range from 3420MHz to 3840MHz when PLL is in function. The frequency of the VCO signal is divided by 2 or by 4 in Mjoelner RF-ASIC. So it is possible to generate the frequency of all channels in GSM900 and GSM1800 (both RX and TX). Frequency of the VCO is controlled by DC voltage (Vc) coming from the PLL loop filter. Range of Vc when PLL is in function is 0.7V– 3.8V. Typical tuning sensitivity of the VCO is 250MHz/V. Even if PLL is not working (Vc out of range) there is a frequency at the output of the VCO, which is between 3 and 4 GHz (if the VCO itself is ok).

It is important to say that power supply for VCXO (VR3) is only switched 'OFF' in the so-called 'Deep Sleep Mode' and power supply for VCO (G701 VR7) is switched 'OFF' in so-called 'Sleep Mode'.

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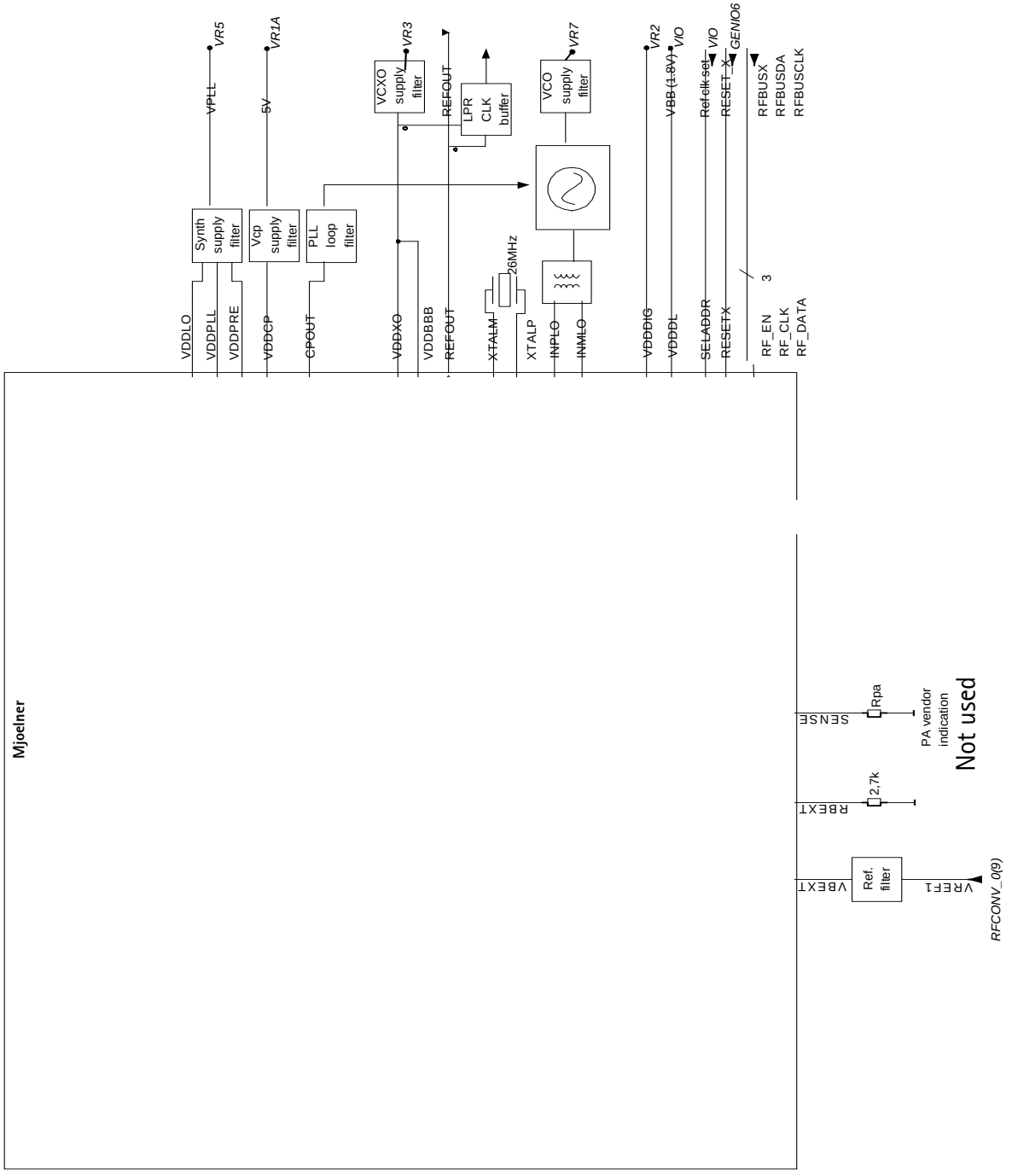
PLL Block diagram



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